

Regolith Derived Heat Shield for a Planetary Body Entry and Descent System with In-Situ Fabrication

Completed Technology Project (2011 - 2012)



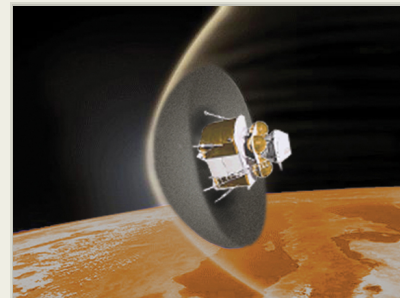
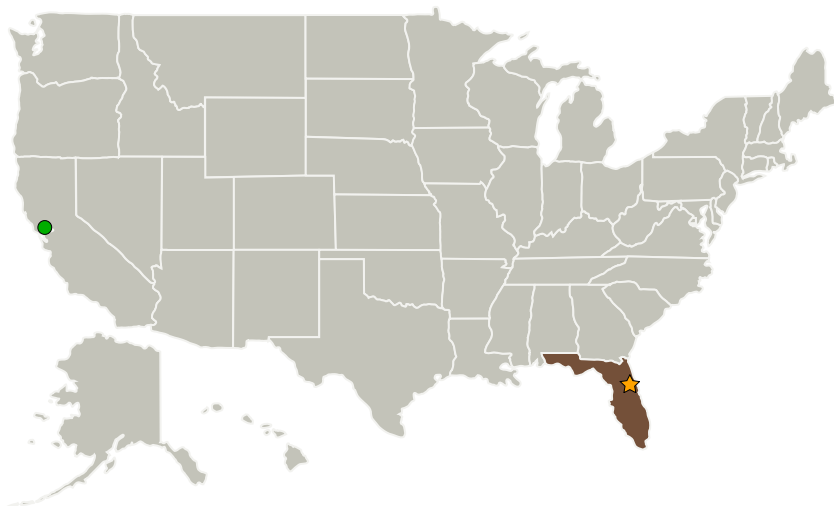
Project Introduction

High-mass planetary surface access is one of NASA's Grand Challenges involving entry, descent and landing (EDL). During the entry and descent phase, frictional interaction with the planetary atmosphere causes a heat build-up to occur on the spacecraft which will rapidly destroy it if a heat shield is not used. However, the heat shield incurs a mass penalty because it must be launched from Earth with the spacecraft, thus consuming a lot of precious propellant. This project proposes to fabricate entry heat shields from the regolith of moons and asteroids. This in situ heat shield fabrication can save tons of mass (and millions of dollars in cost) that has to be transported from Earth.

Anticipated Benefits

This technology could enable a completely new approach to EDL, as well as result in significant cost and mass savings for spacecraft.

Primary U.S. Work Locations and Key Partners



Project Image Regolith Derived Heat Shield for a Planetary Body Entry and Descent System with In-Situ Fabrication

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Organizations Performing Work	Role	Type	Location
★ Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Busek Company, Inc.	Supporting Organization	Industry Women-Owned Small Business (WOSB)	Natick, Massachusetts

Primary U.S. Work Locations

Florida

Project Transitions

**September 2011:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

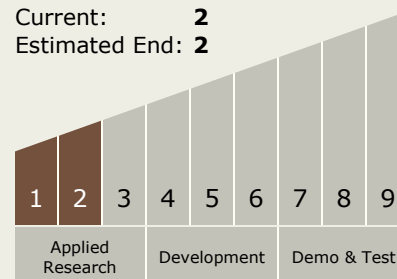
Program Manager:

Eric A Eberly

Principal Investigator:

Michael D Hogue

Technology Maturity (TRL)

Start: **1**Current: **2**Estimated End: **2**

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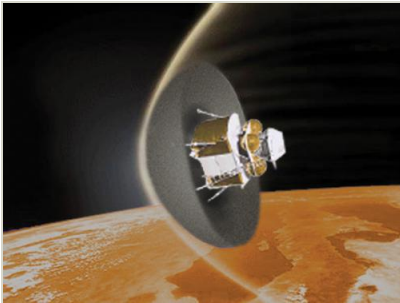
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✓ September 2012: Closed out

Closeout Summary: Within the scope of the testing to date, the feasibility of using extraterrestrial regoliths as the construction material for atmospheric entry heat shields has been confirmed from the results of the acetylene flame and arc jet testing. While some of the arc jet-tested samples were heavily ablated, they provided adequate low temperatures on their rear surfaces. These rear surface peak temperatures were recorded several minutes after arc jet test termination. While the highest energy input (92 W/cm²) at a five minute duration was comparable to a space shuttle re-entry from low Earth orbit, interplanetary atmospheric entry energies can be on the order of about 300 W/cm² or higher. For these type of atmospheric entries, a much thicker regolith derived heat shield would be required than the two inch thick samples evaluated. If the heat shield is fabricated on Phobos or an asteroid, where there is little gravity, then fairly large heat shields can be used to protect returning payloads to Earth. A number of sintered and RTV bound formulations were evaluated. However, samples of JSC-1 Mars with the larger RTV concentrations performed well. In future work, JSC-1 Mars will be replaced by a more representative simulant material using materials that represent characteristics of Phobos and Deimos materials instead. Other lunar material simulants that reflect anorthosite-rich highlands materials are also planned. Much mission architecture work still needs to be performed to determine the full cost/benefit of using regoliths as atmospheric heat shield material. Cost savings for a 20-mission Mars campaign (10 unmanned and 10 manned missions) are estimated to be about \$35 billion dollars if the massive heat shields for each mission did not have to be transported from the surface of the Earth to Mars.

Images



15136.jpg

Project Image Regolith Derived Heat Shield for a Planetary Body Entry and Descent System with In-Situ Fabrication
(<https://techport.nasa.gov/image/102240>)

Technology Areas

Primary:

- TX14 Thermal Management Systems
 - └ TX14.3 Thermal Protection Components and Systems
 - └ TX14.3.2 Thermal Protection Systems

Target Destinations

The Moon, Others Inside the Solar System